Centro Para a Prevenção da Poluição (C3P)

NASA Support for the Portuguese Institute of Environment/Centro Para Prevenção da Poluição

Draft Final Report
May 4, 2004 to May 3, 2005

Executive Summary

C3P is an International Organization recognized by the Portuguese Ministry of Environment, and the United States National Aeronautics and Space Administration (NASA), Director of Environmental Management, per the *Joint Statement between NASA and the Portuguese Ministry of the Environment Regarding Cooperation in the Field of Environmental Pollution Prevention Matters Signed on September 18, 2002.* C3P is a consortia made up by three elements: ITB, Inc.; Instituto de Soldadura e Qualidade (ISQ); and Instituto de Engenharia Mecânica e Gestão Industrial (INEGI).

This report covers all known and anticipated accomplishments between May 4, 2004 and May 3, 2005.

National Level

C3P Active Projects

The currently active C3P Projects are Joint Projects with TAP Portugal, OGMA – *Indústria Aeronáutica de Portugal, S.A*., and Portuguese Air Force (PoAF).

The alternative solution to Chrome Conversion Coatings (for the project *"Identification of Suitable Alternatives to Hexavalent Chrome in Conversion Coatings Alodine 1200/1000 on AL 2024, 7075, 6061"*) under analysis (*PreKote SP*, from Pantheon Chemical) was definitely given impetus during the September 2004 International Pollution Prevention Workshop, in Cape Canaveral. In fact, TAP representatives took advantage of that opportunity to announce their openness to apply it soon in one of their aircraft, thus pairing identical offering previously made public by the Portuguese Air Force.

Parallel to these commercial aviation developments, C3P-Portuguese Air Force relations followed the same path in 2004.
In July, during a working session with the NASA team, the Aircraft Maintenance and Logistics Directorate voluntarily declared itself ready to engage the PREKOTE application in one of their airplanes.
Later in November, its Director, Major General Manuel Chambel, visited NASA Headquarters for the ceremony of signing the C3P-PoAF Cooperation Protocol, and then discussed these and other P2 technical exchange opportunities with NASA. This meeting was however preceded by a visit arranged by C3P-ITB to Wright Patterson AFB, where Major General Chambel and his team were briefed on the F-16 SPO Environmental Program. One can say that the Portuguese Air Force is now accepting and interested not only in the coatings but also other non-polutant alternatives being tested in their fleets.

1. Identification of Suitable Alternatives to Hexavalent Chrome (Cr6+) in Conversion Coating Alodine 1200/1000 on AL 2024, 7075 and 6061.
Project No. C3P.Proj.CCC.Port.001

Background/Need
Chromate conversion coatings offers many advantageous coating properties, it help prepare aluminum for the application of paint and they also provide a corrosion prevention barrier. But on the other hand, Hexavalent Chrome is known to be a serious environmental pollutant.
The chrome, in chemical conversion coatings, was identified in TAP Portugal, OGMA – *Indústria Aeronáutica de Portugal, S.A.*, and Portuguese Air Force (PoAF) as a hazardous material of concern, and target for elimination or reduction.

Objective
Test and implement alternatives to chrome conversion coating in aircraft processing operations at TAP, OGMA and PoAF.

Achievements
- The potential alternative material *PreKote SP* (a non-chromate pretreatment system), from Pantheon Chemical, was evaluated by the stakeholders.
- In July 2004, during a working section with the NASA team, the Aircraft Maintenance and Logistics Directorate from the PoAF voluntarily declared ready to engage *PreKote SP* application in one of their aircrafts.
- During the September Workshop in Cape Canaveral, Florida, meetings with stakeholders helped defined testing phase strategy. TAP representatives announced their openness to apply a non-chromate conversion coating in one of their aircraft, thus pairing identical offering previously made public by the PoAF.
- Laboratory tests began in October, 2004.

- In October 2004, at TAP plating shop, the application of *Prekote SP*, by immersion process, was performed to several test panels for subsequent Salt Spray Testing (corrosion resistance test) (Figure 1). Pantheon Chemical provided technical expertise to ensure that materials were properly applied and that the appropriate surface preparation procedures have been provided by TAP/OGMA.

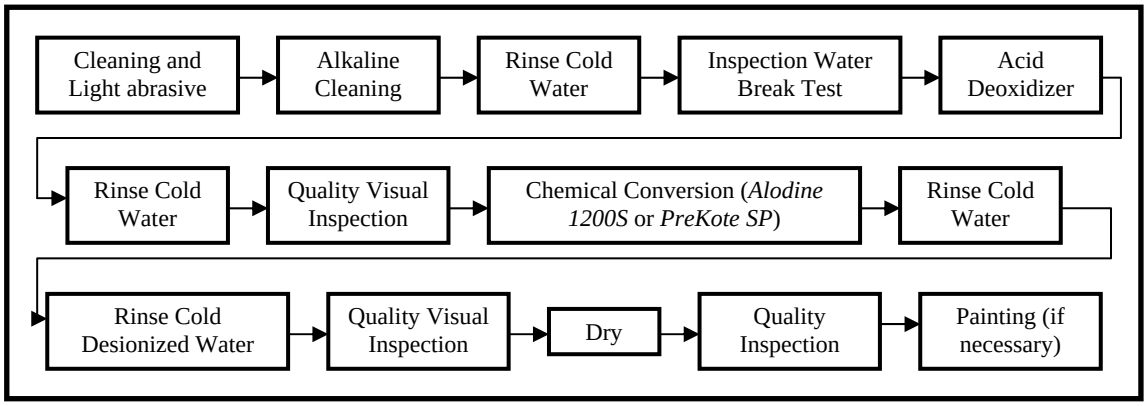

Figure 1. Dip Application Process Flow Chart.

- Update/modification of the technical documents: PAR and Field Test Evaluation Plan.
- In November 2004, the Aircraft Maintenance and Logistics Directorate Director, Major General Manuel Chambel, visited NASA Headquarters for the ceremony of signing the C3P-PoAF Cooperation Protocol, and then discuss the *PreKote SP* application on one of their aircraft and other P2 technical exchange opportunities with NASA.
- An F-16 from the PoAF fleet shall be painted with a non-chromate conversion coating in the second trimester of 2005.
- In March 2005 the immersion tests with *PreKote SP* were repeated at TAP plating shop, due to some problems occurred during the first primer and topcoat application. The test panels were shipped to OGMA to perform Salt Spray Test.

Next Steps
- Completion of technical documents: PAR and Field Test Evaluation Plan.
- Begin field testing. Coating application on a PoAF aircraft.
- Continuation of laboratory testing.
- Prepare draft JTR document.

2. Replacement of High VOC Coatings for Aircraft Painting, and in general painting scheme.
Project No. C3P.Proj.Voc.Port.001

Background/Need
The purpose of this project is to meet the challenges of EU and Portuguese directives to reduce and eliminate VOC emissions.

Objective
Test and implement alternatives to currently used high VOC coatings by TAP Portugal and OGMA – *Indústria Aeronáutica de Portugal, S.A.*.

Achievements
- Both OGMA and TAP have agreed to start this project in September 2004.
- TAP and OGMA representatives started collecting high-VOC processes data.
- Contact with TAP and OGMA engineers to maintain project focus and request process information.

Next Steps
- Preparation of technical documents draft: JTP, PAR and Field Test Evaluation Plan.
- Begin Laboratory and field testing.

3. Demonstration/Validation of Suitable Alternatives to Hexavalent Chrome in Primer Coatings (AL 2024, 7075, 6061).
Project No. C3P.Proj.CPC.Port.001

Background/Need
Chromate primers coatings offer many advantageous coating properties, but Hexavalent Chrome is known to be a serious environmental pollutant.
TAP Portugal and OGMA – *Indústria Aeronáutica de Portugal, S.A.,* identified hexavalent chrome as a hazardous material of concern, and target for elimination or reduction.

Objective
Test and implement alternatives to primer coatings containing hexavalent chrome used in aircraft processing.

Achievements
- Both OGMA and TAP have agreed to start this project in September 2004.
- TAP and OGMA representatives started collecting high-VOC processes data.
- Contact with TAP and OGMA engineers to maintain project focus and request process information.

Next Steps
- Preparation of technical documents draft: JTP, PAR and Field Test Evaluation Plan.
- Begin Laboratory and field testing.

4. Replacement of Chromate and High VOC Coating Systems for Aircraft Painting.
Project No. C3P.Proj.CS.Port.001

Background/Need
A common coating system on aluminum substrates consists of a chromate conversion coating, a primer and a topcoat.
Chromate conversion coatings and primer coatings offers many advantageous coating properties, but on the other hand, Hexavalent Chrome is known to be a serious environmental pollutant. Also, paints that contain high VOC are toxic to human health.
Hexavalent Chrome and VOCs were identified in both TAP Portugal and OGMA – *Indústria Aeronáutica de Portugal, S.A.*, as hazardous material of concern, and target for elimination or reduction.
The objective of this project is to meet the challenges of EU and Portuguese Directives to reduce and eliminate VOC emissions.

Objective
Test and implement chrome free and low VOC coating systems in aircraft painting scheme at TAP Portugal and OGMA – *Indústria Aeronáutica de Portugal, S.A.*.

Achievements
- In September 2004, at the C3P/NASA 2004 International Pollution Prevention Workshop, the C3P TAP/OGMA project team, lead by the initiative of TAP engineers, decided to conduct application and flight testing of coating systems that could potentially meet the requirements of the following projects:
  - → Alternatives to hexavalent chrome in conversion coatings Alodine 1200/1000 on AL 2024, 7075 and 6061. (Project no. C3P.Proj.CCC.Port.001)
  - → Replacement of high VOC coatings for aircraft painting and in general painting scheme. (Project no. C3P.Proj.Voc.Port.001)

→ Dem/Val of suitable alternatives to hexavalent chrome in primer coatings (AL 2024, 7075, 6061). (Project no. C3P.Proj.CPC.Port.001)

- Arrangements were made to apply alternative coating systems on a TAP Airbus A319 over the period Oct. 16 to Nov. 5. Due to limitations on the supply of sufficient materials to paint the entire aircraft, TAP engineers elected to apply the alternative coating system on a service door of the TAP Airbus A319. Worthy to mention is that the applied coating materials were provided at no cost to TAP, and that coating supplier Pantheon Chemical provided technical expertise to ensure that materials were properly applied as well as to provide applicator training to representatives of TAP, OGMA and the PoAF.

- Two coating systems were applied to the service door of an Airbus A319 in the following manner:
  - **Upper half**: High Solids AKZO NOBEL painting scheme:
    M790E, for surface preparation
    Aviox CF Primer
    Aviox Finish 77702
  - **Lower half:** Pantheon Chemical Conversion Coating + High Solids AKZO NOBEL painting scheme:
    PreKote Chemical Pretreatment
    Aviox CF Primer
    Aviox Finish 77702

M790E application: Once the *PreKote* process is complete, the door was masked down the centerline with plastic sheet to avoid contamination of the *PreKote* treated side of the aircraft. The upper half was then wiped with M790E and left for four hours to cure.
Primer/Topcoat application: After the four hour cure time had elapsed, the AKZO NOBEL Primer and Topcoat were applied over both the M790E and *PreKote* treated portions of the door.

- Data regarding the specific TAP and OGMA processes have been incorporated in the JTP and PAR documents.
- The alternative coating systems (PreKote/Aviox) shall be tested against AMS3095 specification for suitability as a replacement of currently used coating technologies (Table 1). All these tests shall be conducted by C3P project stakeholders as in-kind contribution, with TAP preparing all of the panels required for the laboratory tests.

Table 1. TAP/OGMA PreKote-Aviox System Laboratory Tests Matrix.

Test	Test Method	Institution
1. Gloss	ISO 2813 60º meter	NASA
2. Initial Color	ISO 7724 5.3	NASA
3. Adhesion-Cross Hacth	ISO 2409 Tape: 3M 250 (not older than 3 months from date of manufacturing)	OGMA
4. Impact	ISO 6272	ISQ
5. Flexibility-Conical Mandrel	ISO 6860	ISQ
6. Flexibilty-Cylindrical Mandrel	ISO 1519	NASA
7. Water Resistance a) Blistering b) Grade c) Penetration	 ISO 4628 ½ ISO 2409 ISO 1518 Use 1200g (2.6lb) needle weight	ISQ
8. Fluid Resistance	ISO 1518 Use 1200g (2.6lb) needle weight	ISQ
9. Corrosion Resistance-Filiform	EN 3665 1000 hours	ISQ

10. Corrosion Resistance-Salt Spray	ISO 7253 3000 hours	OGMA
11. Artificial Weathering	ISO 2813 60º meter ISO 7724	ISQ and/or NASA
12. Washability (cleaning efficiency)	ISO 2813 60º meter	ISQ
13. Strippability	5.4	ISQ
14. Restoration	5.5	Repeat all tests
15. Heat Stability	ISO 1519, ISO 3270	ISQ or NASA

- The first Inspection of TAP Airbus A319 Service Door was conducted in January 2004. Thickness and Gloss measurements, after two and half (2 ½) months in Service Period, were taken in both RH#1 door upper and lower parts. TAP engineers provided a Follow-Up Report with the inspections results. The final conclusions were:
  - ✓ Careful observation revealed that both paint schemes are in perfect conditions. No peeling-off and other defects were observed.
  - ✓ There was no evolution on both thickness and gloss measurements.
  - ✓ The high DOI (*Distinctness of Image*) found after two and half (2 ½) months in Service Period is reason for do not make short periods of inspections.
- Service door inspections shall be performed in every three (3) months on the first year, and monthly in the next years, if necessary. The next inspection shall be in April 2005.

- In March 2005 the immersion tests with *PreKote SP* were repeated at TAP plating shop, due to some problems occurred during the first primer and topcoat application. The test panels were shipped to OGMA to perform Salt Spray Test.

Current Problems

- ISQ is not able to conduct *Heat Stability Test* (no. 15) due to equipment requirements (ISQ don't have the necessary capabilities required to perform this test). Also, ISQ is not able to conduct the complete *Artificial Weathering Test* (no. 11). Waiting a respond on the possibility of NASA performing *Heat Stability Test* and part of *Artificial Weathering Test.*

Next Steps

- Begin laboratory testing.
- Second inspection of service door of TAP Airbus A319 in April 2005.
- Complete the technical documents.
- Prepare draft JTR document.

Other C3P Activities

During 2004, C3P-participated projects registered the following evolution:

- The National Lead Free Solder Project, as well as the National Recycled Polymer Concretes Project, were submitted to local official funding programs during the first semester.
- Conversely, the VOC's Project proposal presented to the European Commission in 2003, did not receive their agreement for funding, mainly due to the absence of sound innovative outcomes and of a clear return for the stakeholders. Although this means that its sole demonstration-validation rationale, as a C3P process, is not sufficient to meet the EC funding rules and requirements, the project in question is presently being reformulated in order to be submitted to national supported programs.

Still in 2004, C3P worked with SPI, the Portuguese Society for Innovation, over the adequate preparation of a report ordered by FLAD, the Portuguese-American Foundation for Development, on 10 selected , best demonstrated success cases of technological cooperation, among which C3P was mentioned.

By the same token, information and briefings pertaining to C3P activities were provided to the Official Science and Technology Representative to the Portugal-USA Bilateral Relations Committee (Ministry of Foreign Affairs- Department of State) that regularly meets in Lisbon and Washington DC.

Regular contacts have been maintained with The Ministry of Environment, through the Minister's Cabinet.

International Level

At an international level, C3P actions included:

- Meetings with the UK based BAE Systems and TWI, the Welding Institute, to assess the progress of the implementation of a European Lead Free Solder Project.

- C3P presence at the Farnborough Air Show, UK, in July 2004, to disseminate C3P information and contacts among major International companies.

- Participation of C3P and ISQ as members of the Environmental Quality and the Customer Support and Development Committees/Working Groups of the Aero Space and Defense Association of European Industries (ASD).

- A number of meetings with representatives of the Portuguese Association of Printers, Publishers and Periodicals (AIND), together with the European Federation of Magazine Publishers (FAEP) and the European Association of Newspapers (ENPA), to discuss a possible intervention in the VOCs area.

- Contacts with the Spanish Innovation Development Foundation, INASMET, under the auspices of ISQ, which led to the acceptance and signature of a Joint Exchange Protocol.

- Visits to several Aerospace and Defense Companies in Poland, under a NATO/NIAG sponsored initiative. It is hoped that these efforts will lead to positive results in the near future.

- C3P Joint Oversight Group (JOG) meeting and NASA/C3P International Pollution Prevention Workshop, on September 21 and September 22-23, 2004, respectively in Cape Canaveral, Florida. The JOG meeting provided a forum to discuss at the executive level the 2004 accomplishments of C3P as well as the strategic goals for 2005. The workshop provided up-to-date information on solutions and lessons learned on joint pollution prevention projects, as well as visual demonstrations of P2 solutions at Kennedy Space Center.

- C3P/NASA meeting in Lisbon, in October 2004, provided a forum to discuss the way ahead of the TAP/OGMA *Coating System* Project, as well as possible projects areas for 2005. At the same time, two alternative coating systems (PreKote/Akzo Nobel painting scheme) were applied on a service door of a TAP Airbus A319, with Pantheon Chemical technical expertise, to ensure that materials were properly applied.

- Contacts with SETCOM which led to the agreement of signing the Exchange Protocol that shall happen in a nearby future.

Development of ideas for Potential Projects in 2005

As a final outcome of C3P/NASA discussions that took place during the JOG meeting and after the September Workshop, aiming at the definition of potential projects or project areas of mutual interest to be dealt with in 2005. NASA/ITB, ISQ and INEGI engineers developed a list of potential projects for 2005. Below is a listing of projects by entity.

NASA/ITB

1. Validation of suitable alternatives to hexavalent chrome in conversion coatings and primer coatings for aluminium substrates.
2. Identification, demonstration and validation of alternatives to high volatile organic compounds (VOC) primers and topcoats containing methyl ethyl ketone, toluene and xylene.
3. Demonstration of innovative VOC emission control technology for use in industrial applications.
4. Validation of alternatives to lead-containing dry film lubricants for antigalling/antifretting, antiseizing, and assembly aid applications.
5. Validation of suitable low-VOC and HazMat free technologies for depainting on aluminium and composite substrates.

INEGI

1. Biodegradable non-toxic lubricants for automotive applications.
2. End if Life Vehicles – Valorization of polymeric materials waste (plastics, composites...).
3. Fuel Cells.
4. Hydrogen and methanol innovative production of Fuel Cells.
5. Ethanol bioproduction for internal combustion engines.

ISQ

1. Lead free soldering.
2. Environmental monitoring through satellite (Earth observation).
3. Water management of transboundary catchments through satellite.
4. Noise control in aerial transportation.
5. Air pollution control through analysis, modelling and control.

Anticipated Accomplishments

Activities to develop until May 2005:

- C3P/NASA meetings in Lisbon, schedule for April 25-29, with the following objectives:
    1. Support the laboratory testing schedule as per C3P TAP/OGMA Coating System Project; discuss field testing results; and possible visit to TAP to view the service door of TAP Airbus A319 with the PreKote/Akzo Nobel coating system.
    2. Attend meetings regarding the 2005 P2 Workshop and JOG.
    3. Meetings with C3P Members to discuss possible new projects ideas for 2005.

- Painting of an F-16, from the Portuguese Air Force, with a non-chromate conversion coating.